



Ant species (Hymenoptera, Formicidae) of forest fragments and urban areas in a Meridional Amazonian landscape

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Abstract: In this paper we list the ant species collected in both remaining forests and urban areas in a South Amazonian landscape. The list includes 102 species, of which 29 are new records for the state of Rondônia, Brazil. This work demonstrates the gap in ant biodiversity surveys for Meridional Amazon as well as encouraging further research in this region.

Key words: Amazon Forest; anthropic species; Neotropical Region; Rondônia; taxonomic gap; disturbance specialists

INTRODUCTION

Considering the arthropods that inhabit the soil or the canopy of tropical forests, ants (Insecta, Hymenoptera, Formicidae) are among the most abundant organisms, accounting for 90% of the individuals and up to 95% of the animal biomass in some localities (Moffett 2000). Ants are a diverse group of eusocial insects both morphologically and behaviorally with about 13,000 described species (Kaspari 2005; Brandão et al. 2009; Bolton 2015). They play key roles in the environment, interacting with many organisms (Toro et al. 2012; Gallego-Roperio et al. 2013; Vicente et al. 2014), including other ants (Toro et al. 2012; Powell et al. 2014), and are considered ecosystem engineers (Toro et al. 2012). Therefore, ants are excellent models for biodiversity assessments and reliable biological indicators given their high diversity, easy sampling and relatively well-settled taxonomy (Agosti et al. 2000).

Despite the importance of ant inventories to support decision-making and mitigation plans of biodiversity loss (Alonso and Agosti 2000) and ant diversity in the Neotropical region (Kempf 1972; Brandão 1991; Fernandez and Sendoya 2004), local inventories of

the Brazilian ant fauna are historically concentrated in areas of the Cerrado (Schoereder et al. 2010; Camacho and Vasconcelos 2015), Atlantic Forest (Silva et al. 2007; Melo et al. 2014), and more recently in some localities of the Pantanal (Battirola et al. 2005; Silva et al. 2013) and Caatinga (Neves et al. 2013; Ulyssea and Brandão 2013). However, local surveys in the Brazilian Amazon have focused primarily on the central and eastern areas (Santos et al. 2008; Harada et al. 2013; Miranda et al. 2012).

Rondônia is a Brazilian state located near the border with Bolivia, in the meridional Amazon, whose biodiversity is not well known (Petini-Benelli 2015), especially regarding ants. To contribute to the knowledge of the ant diversity of the region that represents one of the main taxonomic gaps for the Neotropical fauna, this paper lists the ant species found in urban areas and Amazon Forest fragments in the municipality of Cacoal, Rondônia, Brazil.

MATERIALS AND METHODS

The study was conducted in the municipality of Cacoal, Rondônia, Brazil, a South Amazonian landscape, in the coordinates 11°26'19" S, 061°26'50" W (Figure 1). Samples were collected between May and August 2013 in 24 locations, including 16 collecting sites in urban backyards, with different distances, sizes and periods of human occupation, and eight collection sites in forest fragments surrounding the city, also different in size, matrix types and degrees of conservation (Figure 2). At all sampling sites two collection methodologies were used. In the first methodology 10 attractive traps containing about 1 cm³ of carbohydrate (honey) and protein (sardine) baits were placed. All traps were randomly exposed at an average distance of 5 m from each other, at ground level, for a period of about 1

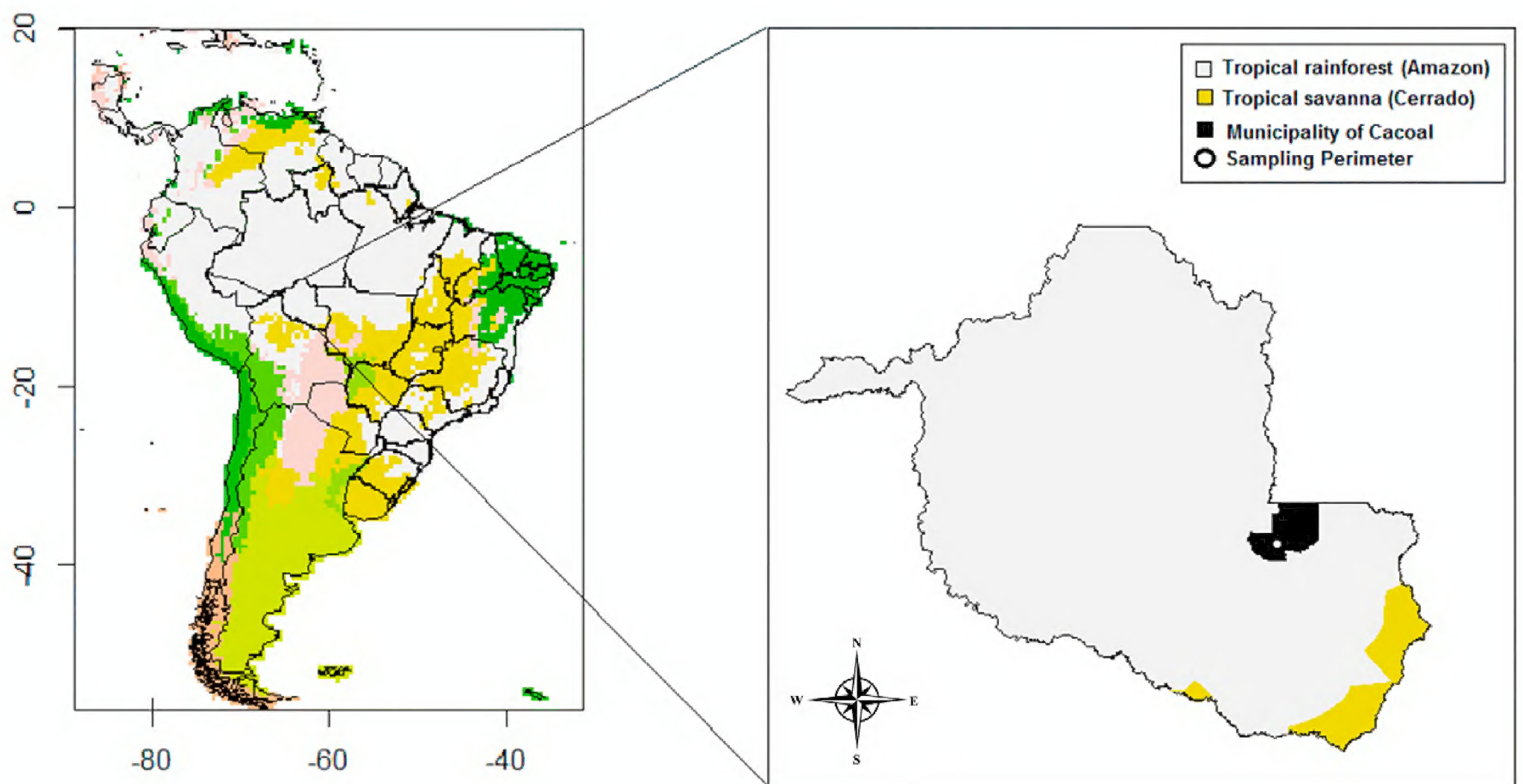


Figure 1. Map showing the state of Rondônia, the municipality of Cacoal (black area), and the sampling perimeter (white circle).

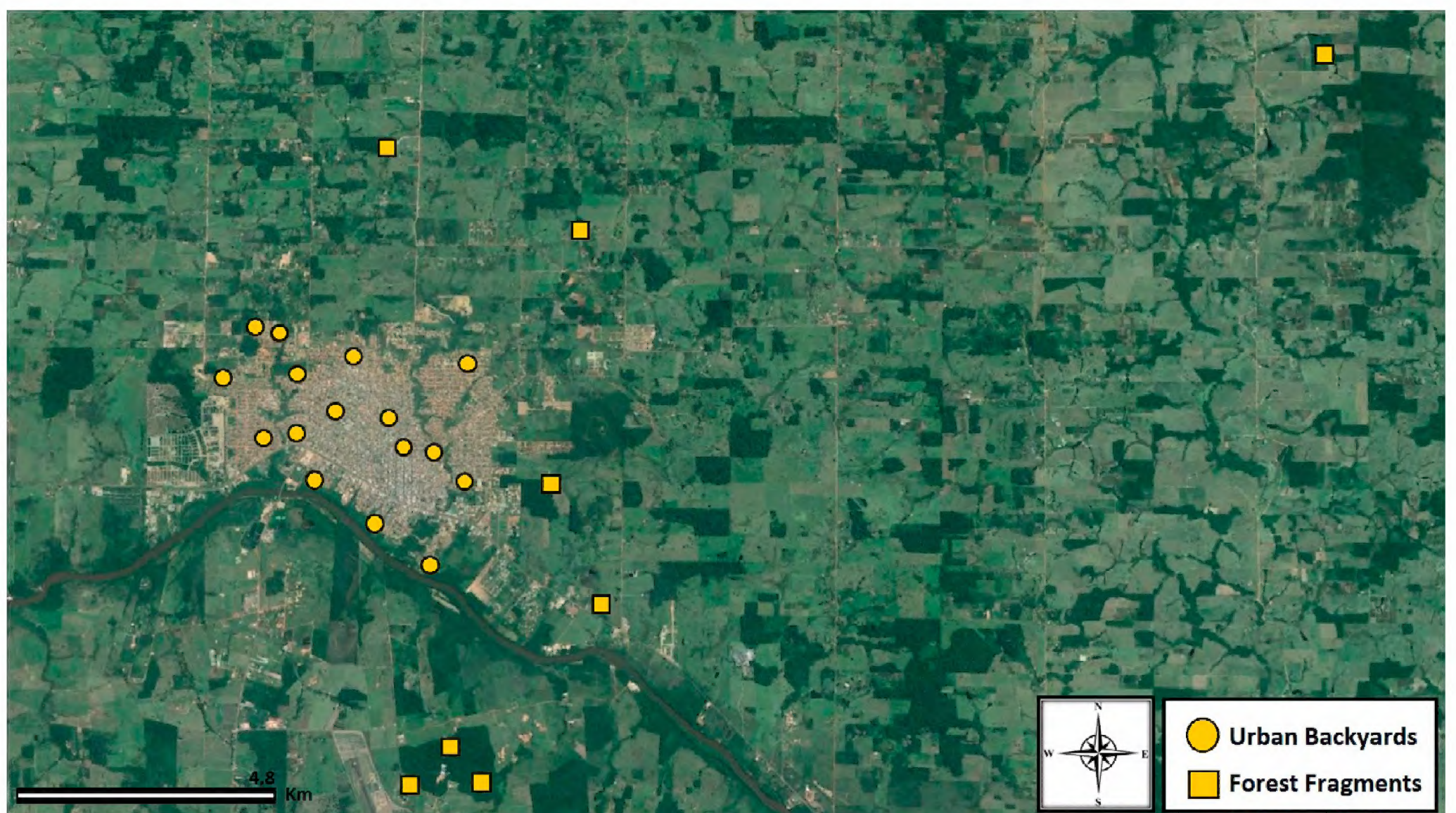


Figure 2. Collecting points at the municipality of Cacoal, state of Rondônia. Urban backyards are represented by yellow circles and forest fragments by yellow squares. Scale bar: 4.8 km.

hour. In the second methodology, an area of 10 m² was demarcated, where active search was conducted to capture all the individuals found foraging within the perimeters of the collection site during a period of one hour, with the help of tweezers, brushes and plastic vials containing alcohol. In this methodology, an exhaustive search was conducted in most of the micro-habitats of

the previously defined areas, such as buildings, wood piles, construction waste, vegetation, rotting logs, twigs, and litter. Although the distance between the bait may have generated a subsampling (see Baccaro et al. 2011), the complementarity of the methods may have minimized this problem, which is corroborated by the high diversity of ants sampled in this study.

The ants collected were initially identified with the dichotomous key of Fernández (2003) to the genus level and then separated into morphotypes. Later, they were identified to species following the bibliographic information present in the same work and deposited in the Coleção Entomológica Padre Jesus Santiago Moure of the Departamento de Zoologia da Universidade Federal do Paraná (DZUP), Brazil. The classification follows Bolton (2015). To determine the distribution of species we consulted the interactive map AntMaps.org (2015), an application created based on bibliographic database of the Global Ant Biodiversity Informatics (GABI) Project. The database, updated weekly, has so far compiled ca. 1.6 million records for about 15,000 species/subspecies in 8,430 publications, museum collections and specimen databases (Economo et al. 2015). We also performed a search using the Scopus and ISI Web of Science portals to identify papers on taxonomic revisions, biology, distribution, and also regional lists of species.

Figure 1 was made using the R software v.3.2.1 (R Core Team 2015) with the packages dismo (Hinmans et al. 2015) and maptools (Bivand and Lewin-Koh 2015) and Figure 2 with Google Earth™.

RESULTS

A total of 102 ant species was recorded, belonging to eight subfamilies and 38 genera (Table 1). The subfamily with the highest number of species was Myrmicinae (53 species), followed by Formicinae (18), Ponerinae (13), Ectatomminae and Pseudomyrmicinae (six species), Dolichoderinae (five), and Dorylinae and Paraponerinae (one species). The richest genus was *Pheidole* (19 species), followed by *Camponotus* (10), *Crematogaster* (seven species), *Pseudomyrmex* (six species) and *Solenopsis* (five species). Regarding the habitat type, 56 species were collected in urban backyards, 75 in forest fragments and 29 in both habitats. Twenty-nine species are recorded for the first time in Rondônia, 11 specific to urban backyards, 11 in forest fragments and seven occurring in both habitats. Among the collected ants,

five are known worldwide as tramp ants, including *Tapinoma melanocephalum* (Fabricius, 1793), *Wasmannia auropunctata* (Roger, 1863) (except for Neotropical region from where it is native), *Tetramorium bicarinatum* (Nylander, 1846), *Brachymyrmex patagonicus* Mayr, 1868, and *Paratrechina longicornis* (Latreille, 1802); the last three represent new occurrence records for the state of Rondônia.

DISCUSSION

The overall species richness found in this inventory corresponds to that reported in other ant surveys (Ryder-Wilkie et al. 2010; Neves et al. 2013; Melo et al. 2014). Myrmicinae, Formicinae and Ponerinae are the subfamilies with higher generic and specific diversity, respectively (Bolton 2015). The same is true for the genera *Camponotus* and *Pheidole* that presented a high diversity in this study, and are also the more speciose ant genera in the world (Fernández and Sendoya 2004; Ryder-Wilkie et al. 2010). *Pheidole*, for example, is known for its hyper-diversity with more than 1,000 described species (Wilson 2003; Bolton 2015) of which about 460 occur in the Neotropical Region (Fernández and Sendoya 2004). *Camponotus* has about 1,100 described species worldwide, of which about 350 are Neotropical (Fernández and Sendoya 2004; Bolton 2015).

Many of the species collected here have wide distributions, including the Amazon biome (Fernández and Sendoya 2004; Miranda et al. 2012; Lutinski et al. 2013). However, 29 species are recorded for the first time in Rondônia, including some species considered tramp ants such as *Brachymyrmex patagonicus*, *Paratrechina longicornis* and *Tetramorium bicarinatum* (Chacón de Ulloa 2003; MacGown et al. 2007; Hita-Garcia and Fisher 2011). *Brachymyrmex patagonicus*, popularly named “Dark Rover Ant” is native to the Neotropics, but is an introduced species in the Gulf Coast region of the United States (MacGown et al. 2007). *Paratrechina longicornis* is a pantropical tramp-species introduced in the Neotropics (Fernández and Sendoya 2004), including several Brazilian states (Kempf 1972). However, the

Table 1. List of ant species recorded in each habitat type (urban backyards and forest fragments) in state of Rondônia, the municipality of Cacoal, Brazil.
* New records for Rondônia.

Taxon	Habitat		Voucher Code
	Backyards	Forest	
Dolichoderinae			
<i>Dolichoderus attelaboides</i> (Fabricius, 1775)		X	30QADA
<i>Dolichoderus rugosus</i> (Smith, 1858) *		X	80QADR
<i>Dolichoderus</i> sp. 3		X	30QADSP3
<i>Dorymyrmex spurius</i> Santschi, 1929 *	X		10UADS
<i>Tapinoma melanocephalum</i> (Fabricius, 1793)	X	X	10UATM 10QATM
Dorylinae			
<i>Labidus praedator</i> (Smith, 1858)		X	70QALP

Taxon	Habitat		Voucher Code
	Backyards	Forest	
Ectatomminae			
<i>Ectatomma brunneum</i> Smith, 1858	X	X	10UAEB 70QAEB
<i>Ectatomma edentatum</i> Roger, 1863		X	10QAEE
<i>Ectatomma lugens</i> Emery, 1894*		X	80QAEL
<i>Ectatomma tuberculatum</i> (Olivier, 1792)		X	20QAET
<i>Gnamptogenys grupo rastrata</i> sp. 1	X		50UAGSP1
<i>Gnamptogenys</i> sp. 2	X		70UAGSP2
Formicinae			
<i>Brachymyrmex patagonicus</i> Mayr, 1868*	X		10UABP

Continued

Table 1. Continued.

Taxon	Habitat		Voucher Code
	Backyards	Forest	
<i>Brachymyrmex</i> sp. 2	X	X	45UPBSP2 10QABSP2
<i>Camponotus blandus</i> (Smith, 1858)*	X	X	10UACB 80QACB
<i>Camponotus latangulus</i> Roger, 1863		X	30QACL
<i>Camponotus melanoticus</i> Emery, 1894*	X		40UACM
<i>Camponotus novogranadensis</i> Mayr, 1870	X	X	10UACN 30QACN
<i>Camponotus renggeri</i> Emery, 1894	X	X	21UPCR 10QACR
<i>Camponotus sericeiventris</i> (Guérin-Méneville, 1838)		X	80QACSE
<i>Camponotus</i> sp. 11	X	X	10UACSP11 40QACSP11
<i>Camponotus</i> sp. 8		X	30QACSP8
<i>Camponotus substitutus</i> Emery, 1894*	X		50UACSU
<i>Camponotus vittatus</i> Forel, 1904*	X		20UACV
<i>Gigantiops destructor</i> (Fabricius, 1804)		X	70QAGD
<i>Nylanderia</i> sp. 1		X	50QANSP1
<i>Nylanderia</i> sp. 2	X		26UPNSP2
<i>Nylanderia</i> sp. 3	X	X	30UANSP3 24QPNSP3
<i>Nylanderia</i> sp. 4	X		30UANSP4
<i>Paratrechina longicornis</i> (Latreille, 1802)*	X	X	10UAPL 20QAPL
Myrmicinae			
<i>Acromyrmex landolti</i> (Forel, 1885)*		X	80QAAL
<i>Acromyrmex rugosus</i> (Smith, 1858)	X	X	20UAAR 10QAAR
<i>Acromyrmex subterraneus</i> (Forel, 1893)*	X		10UAASU
<i>Atta sexdens</i> (Linnaeus, 1758)		X	40QAASE
<i>Cephalotes atratus</i> (Linnaeus, 1758)	X	X	30UACA 30QACA
<i>Cephalotes pusillus</i> (Klug, 1824)	X	X	20UACP 70QACP
<i>Crematogaster carinata</i> Mayr, 1862*	X	X	30UACC 83QPCC
<i>Crematogaster erecta</i> Mayr, 1866*	X	X	20UACE 80QACE
<i>Crematogaster evallans</i> Forel, 1907*	X	X	59UPCEV 10QACEV
<i>Crematogaster flavosensitiva</i> Longino, 2003*		X	30QACF
<i>Crematogaster nigropilosa</i> Mayr, 1870		X	40QACNI
<i>Crematogaster obscurata</i> Emery, 1895*	X	X	50UACO 68QPCO
<i>Crematogaster</i> sp. 4		X	50QACSP4
<i>Cyphomyrmex</i> grupo <i>strigatus</i> sp. 1		X	40QACSP1
<i>Cyphomyrmex minutus</i> Mayr, 1862*		X	40QACMI
<i>Cyphomyrmex rimosus</i> (Spinola, 1851)	X	X	60UACRI 70QACRI
<i>Daceton armigerum</i> (Latreille, 1802)*		X	70QADAR
<i>Megalomyrmex ayri</i> Brandão, 1990		X	50QAMA
<i>Monomorium floricola</i> (Jerdon, 1851) *	X	X	12UPMF 10AQMF
<i>Mycocepurus smithii</i> (Forel, 1893) *		X	70QAMS
<i>Ochetomyrmex neopolitus</i> Fernández, 2003		X	41QPON
<i>Pheidole gertrudae</i> Forel, 1886*	X		10UAPG
<i>Pheidole</i> sp. 1	X	X	10UAPS1 10QAPS1
<i>Pheidole</i> sp. 2	X	X	10UAPSP2 30QAPSP2
<i>Pheidole</i> sp. 3	X		70UAPSP3
<i>Pheidole</i> sp. 4	X	X	11UPPSP4 71QPPSP4
<i>Pheidole</i> sp. 5	X	X	10U1PSP5 30QAPSP5
<i>Pheidole</i> sp. 7		X	40QAPSP7
<i>Pheidole</i> sp. 8		X	54QPPSP8
<i>Pheidole</i> sp. 9		X	70QAPSP9
<i>Pheidole</i> sp.10	X		56UPPSP10
<i>Pheidole</i> sp. 11		X	11QPPSP11
<i>Pheidole</i> sp. 12	X	X	17UPPSP12 60QAPSP12
<i>Pheidole</i> sp. 13	X		60UAPSP13
<i>Pheidole</i> sp. 15	X		31UPPSP15
<i>Pheidole</i> sp. 16		X	52QPPSP16
<i>Pheidole</i> sp. 17		X	80QAPSP17
<i>Pheidole</i> sp.18	X		78UPPSP18
<i>Pheidole</i> sp.19	X		60UAPSP19
<i>Pheidole</i> sp. 20	X		43UPPSP20
<i>Pogonomyrmex naegelii</i> Emery, 1878*	X		10UAPN
<i>Procryptocerus subpilosus</i> (Smith, 1860)		X	70QAPS
<i>Sericomyrmex</i> sp. 1		X	50QASSP1
<i>Solenopsis invicta</i> Buren, 1972*	X		12UPSI
<i>Solenopsis richteri</i> Forel, 1909*	X		55UPSR
<i>Solenopsis</i> sp. 2	X	X	33UPSOSP2 40QASOSP2
<i>Solenopsis</i> sp. 3	X		13UPSOSP3
<i>Solenopsis</i> sp. 4	X		51UPSOSP4
<i>Tetramorium bicarinatum</i> (Nylander, 1846)*	X		10UATB
<i>Trachymyrmex opulentus</i> (Mann, 1922)*		X	80QATO
<i>Trachymyrmex</i> pr. <i>mandibularis</i>	X		31UPTPM
<i>Trachymyrmex</i> sp. 1		X	33QPTSP1
<i>Wasmannia auropunctata</i> (Roger, 1863)	X	X	47UPWA 50QAWA
Paraponerinae			
<i>Paraponera clavata</i> (Fabricius, 1775)		X	80QAPC
Ponerinae			
<i>Anochetus bispinosus</i> (Smith, 1858)		X	10QAAB
<i>Anochetus horridus</i> Kempf, 1964*		X	60QAAH
<i>Mayaponera constricta</i> (Mayr, 1884)*		X	10QAMC
<i>Neoponera commutata</i> (Roger, 1860)		X	10QANC
<i>Neoponera crenata</i> (Roger, 1861)		X	30QANCR
<i>Neoponera obscuricornis</i> (Emery, 1890)		X	10QANO
<i>Neoponera verenae</i> Forel, 1922		X	60QANV
<i>Odontomachus bauri</i> Emery, 1892*		X	30QAOB
<i>Odontomachus haematodus</i> (Linnaeus, 1758)	X	X	10UAOH 10QAOH
<i>Pachycondyla crassinoda</i> (Latreille, 1802)		X	12QPPCR
<i>Pachycondyla harpax</i> (Fabricius, 1804)	X	X	10UAPH 20QAPH
<i>Pachycondyla</i> sp. 8		X	10QAPSP8
<i>Pseudoponera stigma</i> (Fabricius, 1804)		X	10QAPST
Pseudomyrmecinae			
<i>Pseudomyrmex gracilis</i> (Fabricius, 1804)	X	X	50UAPGR 70QAPGR
<i>Pseudomyrmex</i> sp. 2	X	X	40UAPSPS2 80QAPSPS2
<i>Pseudomyrmex</i> sp. 5	X		40UAPSPS5
<i>Pseudomyrmex tenuis</i> (Fabricius, 1804)		X	30QAPT
<i>Pseudomyrmex termitarius</i> (Smith, 1855)	X		60UAPTE
Total richness	56	75	

specimens collected here represent the first reports for the state of Rondônia. Another widespread tramp ant, *Tetramorium bicarinatum* (Hita-Garcia and Fisher 2011; Fernández and Sendoya 2004), is also recorded for the first time in Rondônia. Still regarding the invasive ants collected in the present study, only *Wasmannia auropunctata* and *T. melanocephalum* have been previously reported for Rondônia (Mann 1916; Vieira et al. 2013). *Tapinoma melanocephalum* is normally collected in urban environments, and is considered a species of sanitary importance because it can be a vector of Gram-positive bacteria in hospitals (Vieira et al. 2013). Despite its invasive status in different regions of the world, *Wasmannia auropunctata*, cannot be considered exotic in Rondônia, since it is a typical Neotropical species.

In addition to the tramp ants, other species collected are more limited in distribution and represent new records for Rondônia. *Camponotus vittatus* Forel, 1904, here recorded for the first time in Rondônia, is a frequently collected species in Midwest and Southeastern Brazil (Ulysséa and Brandão 2013; Melo et al. 2014; Camacho and Vasconcelos 2015). *Dorymyrmex spurius* Santschi, 1929 occurs in drier environments and nests in bare soil (Shattuck 1992); therefore, it can also be found in grasslands or plantations (Brandão et al. 2011; Costa-Milanez et al. 2014). Its distribution is known for Argentina, Brazil, Paraguay and Uruguay (Shattuck 1994). The records in Brazil were limited, so far, to the states of Maranhão, Minas Gerais, Brasília (Sandoval and Zambrano 2007; Brandão et al. 2011; Costa-Milanez et al. 2014). In this work, *C. vittatus* and *D. spurius* were found only in urban backyards. Another species recorded here with considerable gaps in its distribution is *Crematogaster evallans* Forel, 1907, which has been reported for Guatemala (Branstetter and Sáenz 2012), Costa Rica, Colombia and Brazil (Longino 2003). The known distribution in the Brazilian territory is patchy, with records for Roraima (Baccaro et al. 2012; Souza et al. 2012), Pará (Santos et al. 2008), Goiás (Gallego-Roperio et al. 2013), Espírito Santo, Rio de Janeiro (Longino 2003), São Paulo (Forel 1912), Bahia and Minas Gerais (Ulysséa and Brandão 2013).

The richness of ant species in forest environments was higher (46) than that of urban backyards (27). These results can be partially explained by the presence of arboreal ants, found only in the forest fragments, such as *Camponotus latangulus* Roger, 1863, *Ectatomma tuberculatum* (Olivier, 1792) and *Daceton armigerum* (Latreille, 1802) that, even in forested environments, are more closely related with native vegetation (Marinho et al. 2002). Interestingly, despite its wide distribution along the Amazon (Azorsa and Sosa-Calvo 2008; Vicente et al. 2011), this is the first record of *D. armigerum* for the state of Rondônia.

Labidus praedator (Smith, 1858) was also collected only in forest fragments. This is an army ant species

with huge colonies that requires large areas for foraging (Kaspari et al. 2011; Suguituru et al. 2015). The Ponerinae predatory ants of the genus *Neoponera*, and the species *Mayaponera constricta* (Mayr, 1884) and *Pseudoponera stigma* (Fabricius, 1804) also occurred only in forested areas. These taxa nest mainly in the soil and trunks of fallen dead trees (Schmidt and Shattuck 2014).

Others studies that compared the richness and composition of ants between disturbed and natural areas showed a similar diversity of species when compared to our results (Silva et al. 2008; Vasconcelos et al. 2006), probably related to habitat heterogeneity and resource availability (Ribas et al. 2003; Neves et al. 2013), which is higher in forested areas than in urban backyards. However, it is interesting to note that even with this difference in the richness and composition of ants between habitats, two species of tramp ants reported to the Neotropical Region (*Paratrechina longicornis* and *Tapinoma melanocephalum*) were sampled both in urban backyards and forest fragments. The presence of these species in forest remnants indicates a degree of local environmental degradation in these natural areas. Nevertheless, it is valid to recall that forest fragments are very important for the conservation of native species in changing environments (Vasconcelos et al. 2006; Pacheco et al. 2013).

This study shows that ant communities from disturbed forest areas are similar to those found in other Neotropical areas with some degree of environmental degradation. On the other hand, even with the subsampling approach of this study and the environmental degradation of forest areas highlighted by the presence of tramp ants in the fragments, species diversity of these areas is similar to others studies conducted with baits in relatively well preserved regions of the Amazonian rainforest (Baccaro et al. 2011, 2012). In this sense, this work fills important gaps in the distribution of many ant species both native and exotic due to a lack of systematic surveys of biodiversity in the meridional Amazon. Taxonomic gaps like these are recurrent in many regions of the Amazon Forest, the main tropical rainforest remaining in the world and whose insect biodiversity is still superficially known. We hope that this work may support future studies and encourage new researchers to explore the knowledge of the biodiversity in this region.

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